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Title: Rossi Alpha Method

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Rossi Alpha Method

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NEN-2

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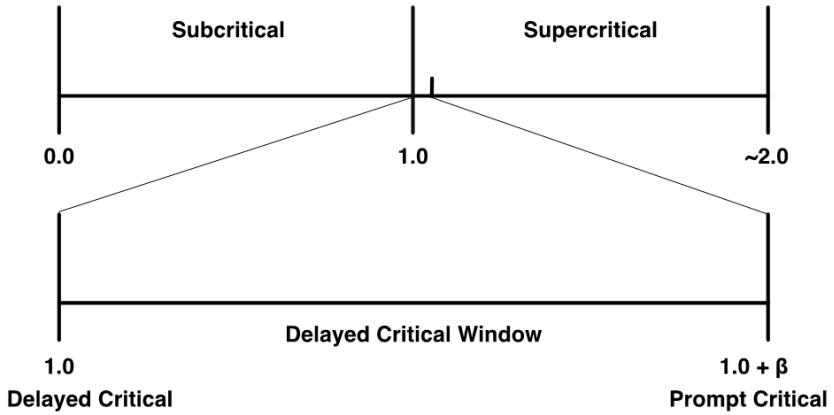
Overview

- Reactor Physics Parameters
- What is Rossi Alpha?
  - Why we care?
- Classical Experiment
- Modern Experiment
- Experimental Procedure
  - Results of Completed work

Reactor Physics Parameters

- Delayed neutrons
- Prompt neutrons
- K_{eff} the multiplication factor calculates the neutron population change between generations
- K_p is the prompt multiplication factor (i.e. multiplication factor due only to prompt neutrons



Reactor Physics Parameters (cont.)

- l - *the neutron lifetime or average time a neutron spends in the media before a terminating event*
- β_{eff} - *delayed neutron fraction*
- ν_p - *number of neutrons promptly emitted*
- Σ_f - *macroscopic fission cross section*
- *Accidental pairs*
- *Correlated pairs*

What is Rossi Alpha?

- *Rossi-α is the prompt neutron decay constant.*
- *The prompt neutron decay constant is a good way to calibrate reactivity without use of the Inhour relation*
- *The Rossi Alpha method is useful when establishing the mass increment between delayed critical and prompt critical*

Theory

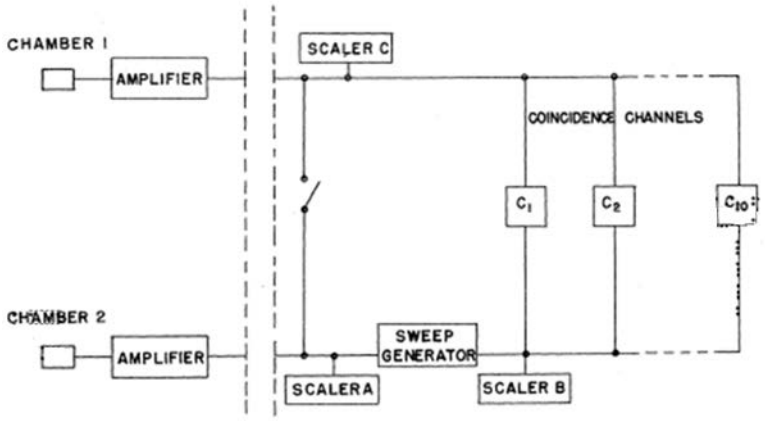
- The probability of detecting two random detection events is:
  - $p_r(t_1, t_2)\Delta_1\Delta_2 = F^2\epsilon^2\Delta_1\Delta_2$
- The probability of detecting a correlated neutron detection event near time t_1:
  - $p_1(t_1)\Delta_1 = \epsilon\nu_p\upsilon\Sigma_f e^{\alpha(t_1-t_0)}\Delta_1$
- The probability of detecting a correlated neutron detection event near time t_2:
  - $p_2(t_2)\Delta_2 = \epsilon(\nu_p-1)\upsilon\Sigma_f e^{\alpha(t_2-t_0)}\Delta_1$

Theory (cont.)

- The total probability of detecting two correlated neutron counts:
  - $p_c(t_1, t_2)\Delta_1\Delta_2 = \int_{-\infty}^{t_1} p(t_1)\Delta_1 p(t_2)\Delta_2 F\, dt_0$
  - $p_c(t_1, t_2)\Delta_1\Delta_2 = F\epsilon^2 \frac{D_v {k_p}^2}{2(1-k_p)l} e^{\alpha(t_2-t_1)}\Delta_1\Delta_2$
- Add both of these probabilities and combined the constants down into A and B to get:
  - $p(t) = A + Be^{\alpha t}$

Classical Rossi Experiment

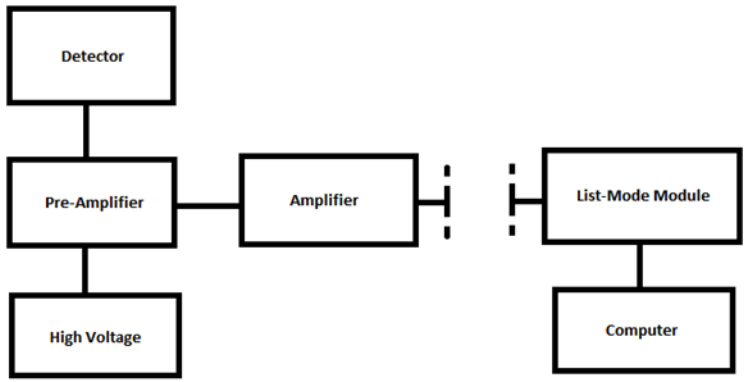
- Most notably performed by John Orndoff
- Used a ten channel time analyzer to time discriminate neutron pulses
- Preset Bin widths



BLOCK DIAGRAM
10 CHANNEL TIME DELAY ANALYZER

Modern Rossi Alpha Experiment

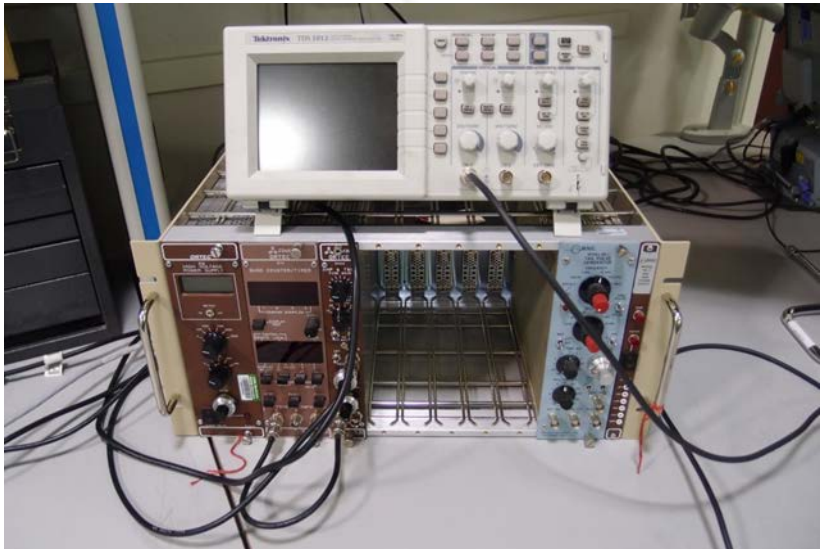
- Uses a List-mode or other piece of hardware capable of time tagging neutron counts
- Has an extra analytical step, but the flexibility to be analyzed in many different ways



Experimental Setup at DAF

Experimental Procedure

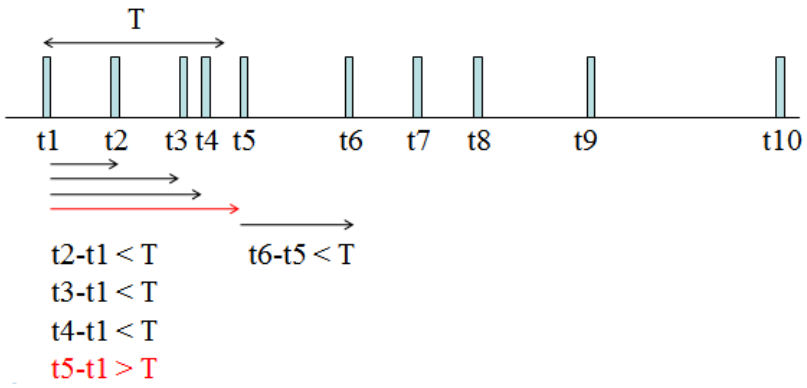
- Measurements must be performed on a neutron multiplying, chain-reacting system
- Simple counting system is used
- Data is placed into a histogram based to the time differences between neutron detection events



NIM Bin for the Rossi Alpha experiment

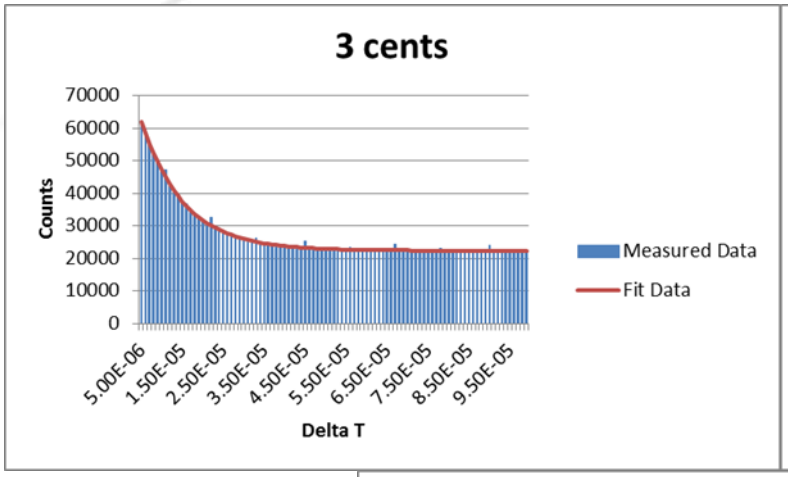
Data Analysis

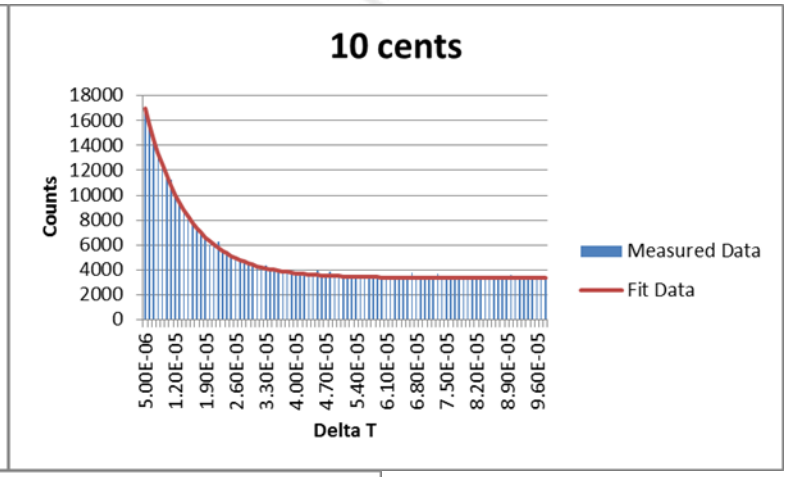
- Heuristic equation developed by Richard Feynman
  - $p(t) = A + Be^{\alpha t}$
  - The A term includes all correlated neutron detection events
  - The B term includes all source neutron detection events (delayed neutrons and other external sources)

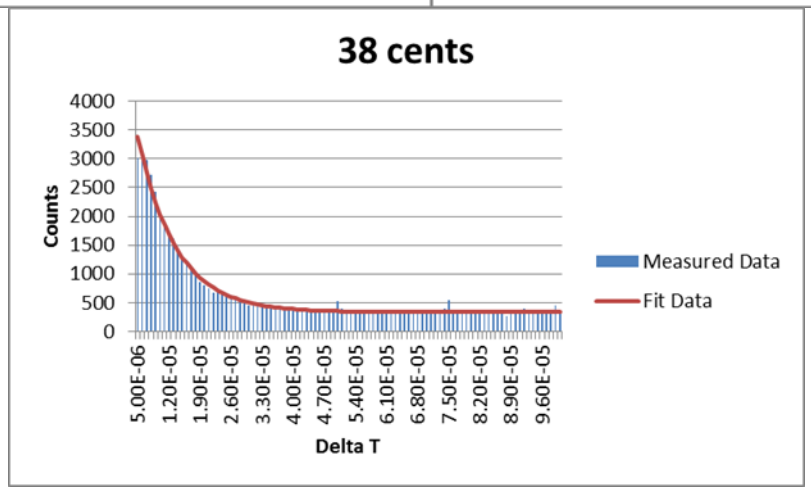


Binning Scheme for Rossi Analysis

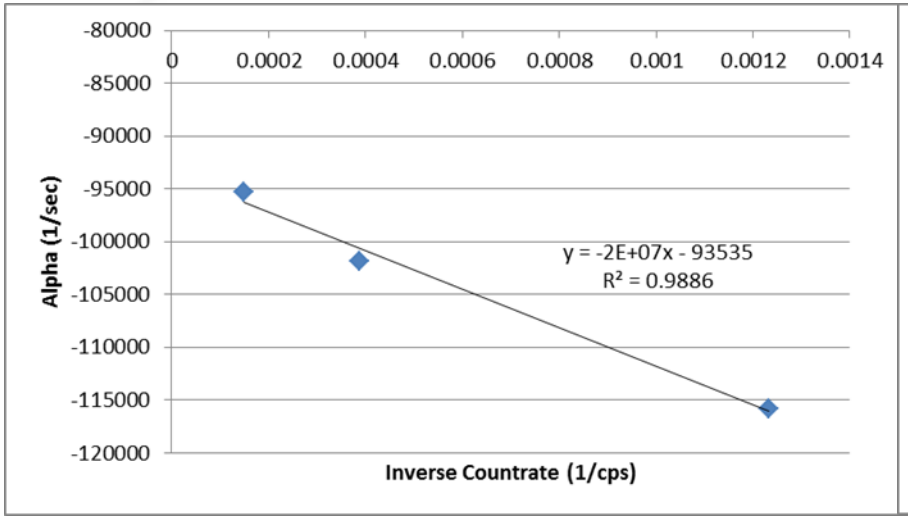
Results

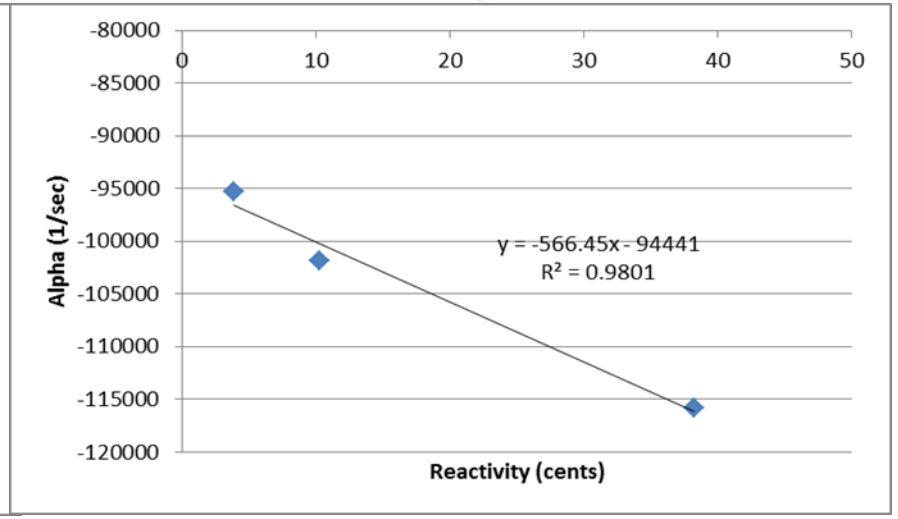






Results (cont.)





Questions and Discussion

- H. C. Paxon and G. E. Hansen, Critical Assemblies and Associated Measurements.
- C. P. Baker, Time scale measurements by the Rossi method.
- R. E. Uhrig, Random Noise Techniques in Nuclear Reactor Systems.
- Ronald.
- J. Orndoff and C. Johnstone, Time scale measurements by the Rossi
- method.
- F. de Hoffman, Statistical fluctuations in the water boiler and time dispersion of neutrons emitted per fission.
- R. Feynman, Statistical behavior of neutron chains.
- G. E. Hansen, The Rossi Alpha method.
- J. D. Orndoff, Prompt Neutron Periods of Metal Critical Assemblies.
- R.G. Sanchez, G.E. McKenzie, T.J. Grove, and J.A. Bounds, Measurement of the Prompt Neutron Decay Constant in a Highly Enriched Uranium Copper Reflected System.